



Illinois Center for Transportation
University of Illinois at Urbana-Champaign

I ILLINOIS

Accelerated Pavement Testing (APT) of Stone Matrix Asphalt (SMA) with Local Aggregate



Dec 11th, 2024 – Illinois Bituminous Paving Conference

I-APT

"Where Excellence and Transportation Meet"

Introduction

- SMA is a **durable** paving material.
- The use of SMA is gaining **momentum**.
- SMA requires fiber, SBS, more binder, and high-quality aggregates, which make it **cost** more than HMA.
- If aggregates were hauled **locally**, SMA production would
 - cost ~20% less
 - emit ~10% less



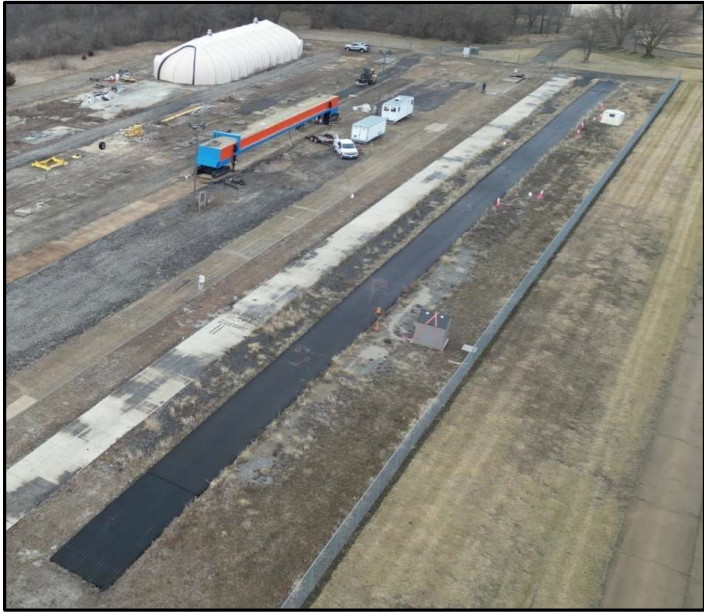
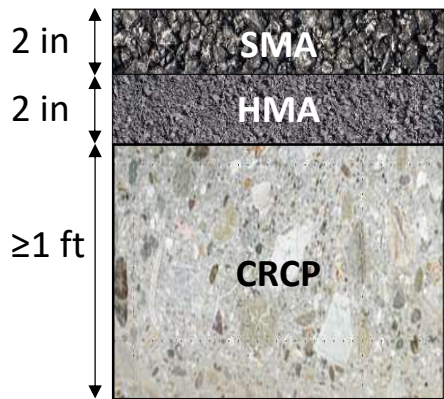
Optimize SMA by using Local Aggregate

- **Objective: Reduce the cost and environmental impact of SMA**
- **Designed 21 SMAs in the laboratory**
 - Reduced compaction effort to accommodate aggregates meeting lesser quality standards
 - Evaluated aggregate skeleton preservation (check breakage)
 - Potential performance
- **Full-scale validation of six selected SMAs**

Six SMA Design Characteristics

SMA	Aggregate Lithology	Design Gyration	Nominal Maximum Aggregate Size (mm)	Combined Water Absorption (%)	Combined L.A. Abrasion (%loss)	Binder Content (%)	Effective Binder Content (%)	Voids in Mineral Aggregate (%)
T1-80-12.5-0	Trap Rock	80	12.5	1.07	11.1	6.0	5.4	16.3
T1-50-12.5-0	Trap Rock	50	12.5	1.11	10.9	6.3	5.6	16.8
D2-50-12.5-0	Dolomite	50	12.5	2.73	13.6	7.0	5.5	16.5
L2-50-12.5-0	Limestone	50	12.5	1.71	16.8	6.4	5.6	16.7
D3-50-9.5-0	Dolomite	50	9.5	2.26	21.5	7.0	5.9	17.4
D4-50-12.5-0	Dolomite	50	12.5	2.24	18.2	6.8	5.5	16.6

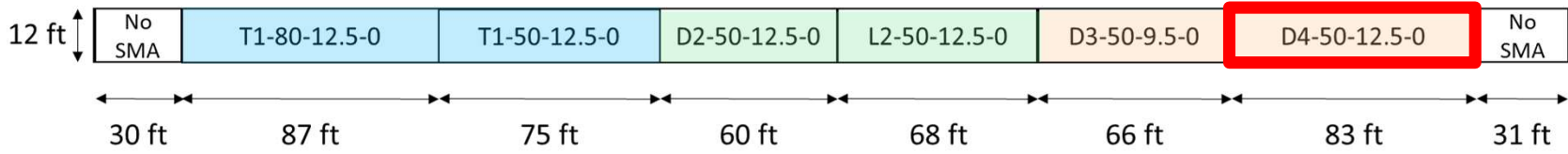
Full-scale Testing Sections



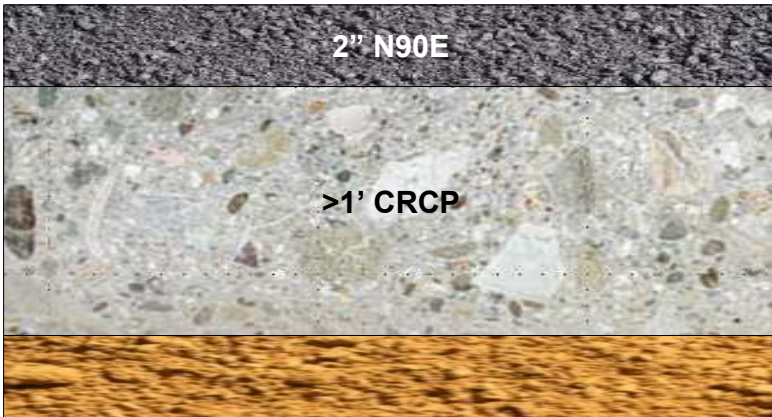
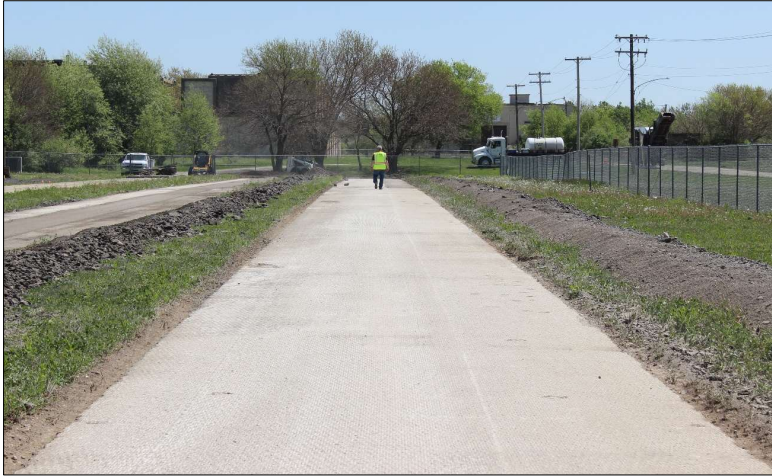
- Compaction Effort
- Imported Agg.

- Limestone vs Dolomite
- Best Available Agg.

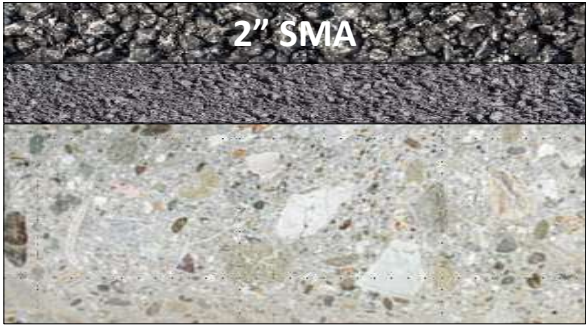
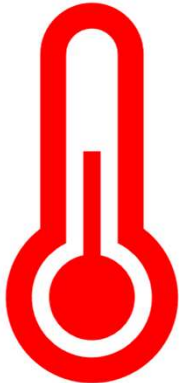
- Different Agg. Qualities
- Dolomite



Base Preparation

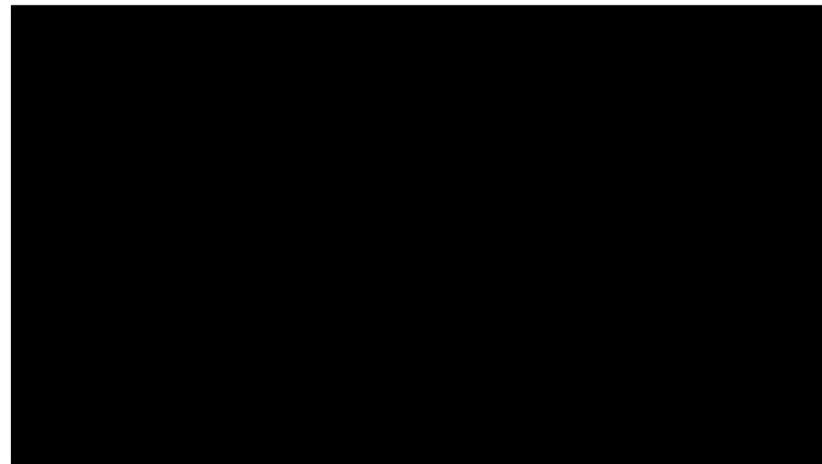
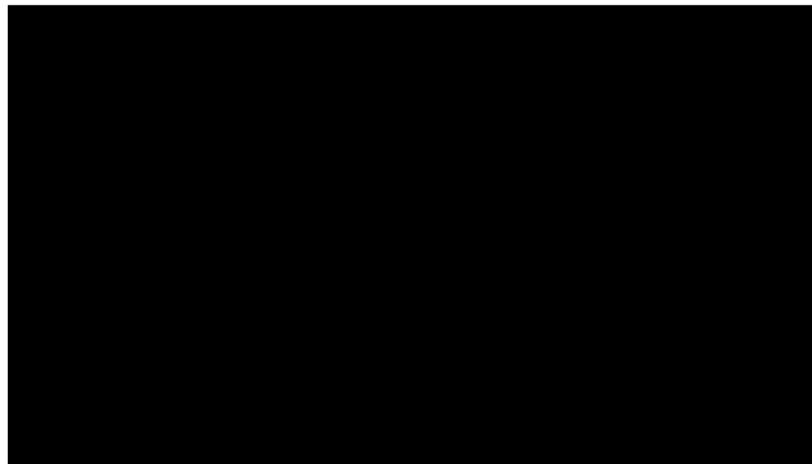
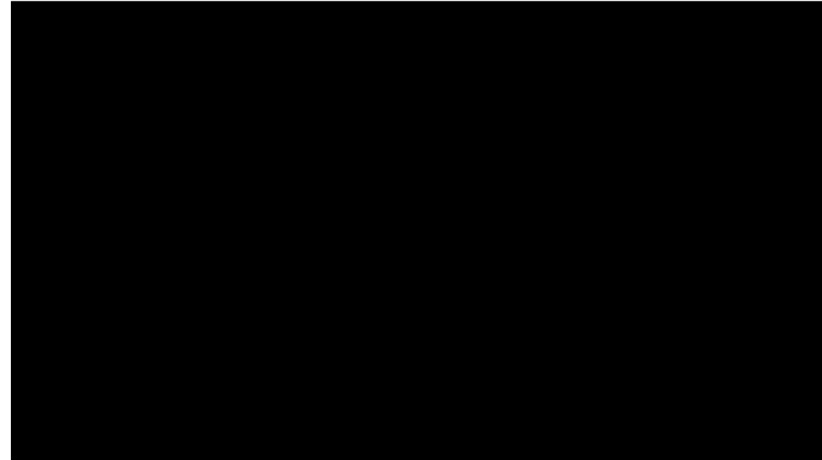
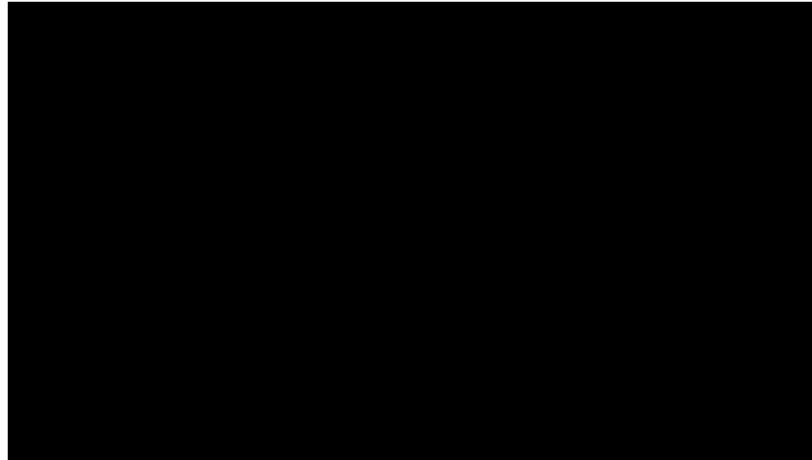


SMA Instrumentation





Illinois Accelerated Pavement Tester I-APT



Experimental Program

- **19 Loading Scenarios (passes to stability)**
 - Axle Loading: Single or Tandem
 - Loading Level: 7, 8, 9, or 10kip
 - Tire Inflation Pressure: 120, 100, or 80psi
 - Speed: 1, 3, or 5mph
- **Rutting at 5mph**
 - Tandem spaced 3.5ft c-c
 - Temperature: 80°F
 - Loading: 10, 12, and 14kip/axle for 60k, 30k, and 30k, respectively.
 - Tire Inflation Pressure: 120psi (both tires)

Data Collection

Hold to stop logging data

Seconds to wait to stop test: 119

Temp to display: T#4

Current Temp (deg C): 28.2

Data is always saved, according to the pass number and pass mode

File path (-Temp_Pass#.csv, -Pressure_Pass#.csv, -Strain_Pass#.csv will be appended)
TYPE BEFORE CLICKING 'RUN' BUTTON ABOVE. DATA COLLECTION WILL START IMMEDIATELY

C:\Users\ICT\PRSENER\Documents\LabVIEW Data\827-216 APT\80_80_10_10_3_80_3.5.10212024_80_80_10_10_3_80_3.5

Thermocouples Sample Rate (Hz): 1

Thermocouples Number of samples to buffer: 1

Pass Mode

- Stop current pass when signal goes low. Start new pass when signal goes high
- Stop current pass when signal goes high. Start new pass when signal goes low
- Stop current pass and start new pass when signal goes high (forward carriage movement)
- Stop current pass and start new pass when signal goes low (reverse carriage movement)

Pass number to start at: 0

Pass number: 20

Manually simulate carriage direction signal

Save data?

Wait seconds: 0.1

Time range (Hours): 0.25

Temp range (deg C): 0.025

Temp range (deg C): 0.2

Temp changed

Seconds of data to keep: 120

Strain Gauges Sample Rate (Hz): 1000

Strain Gauges Number of samples to buffer: 1000

Pressure Cells Sample Rate (Hz): 1000

Pressure Cells Number of samples to buffer: 1000

Temperature (deg C)

Temperature mean

T#4 (Extracted)	31.814
T#1 (Extracted)	10.399
T#2 (Extracted)	8.628
T#3 (Extracted)	12.289
T#4 (Extracted)	12.559
T#1 (Extracted)	27.876
T#2 (Extracted)	27.100
T#3 (Extracted)	28.724
T#4 (Extracted)	28.221

Pressure (MPa)

Pressure mean

Pressure 4 (Extracted)	-0.211
Pressure 5 (Extracted)	0.021
Pressure 6 (Extracted)	0.022
Pressure 7 (Extracted)	0.020

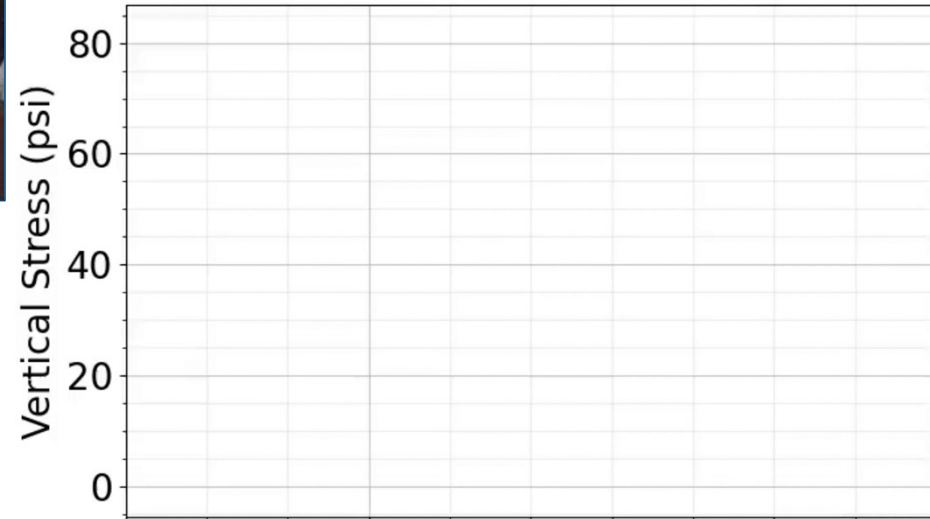
Microstrain

Strain mean

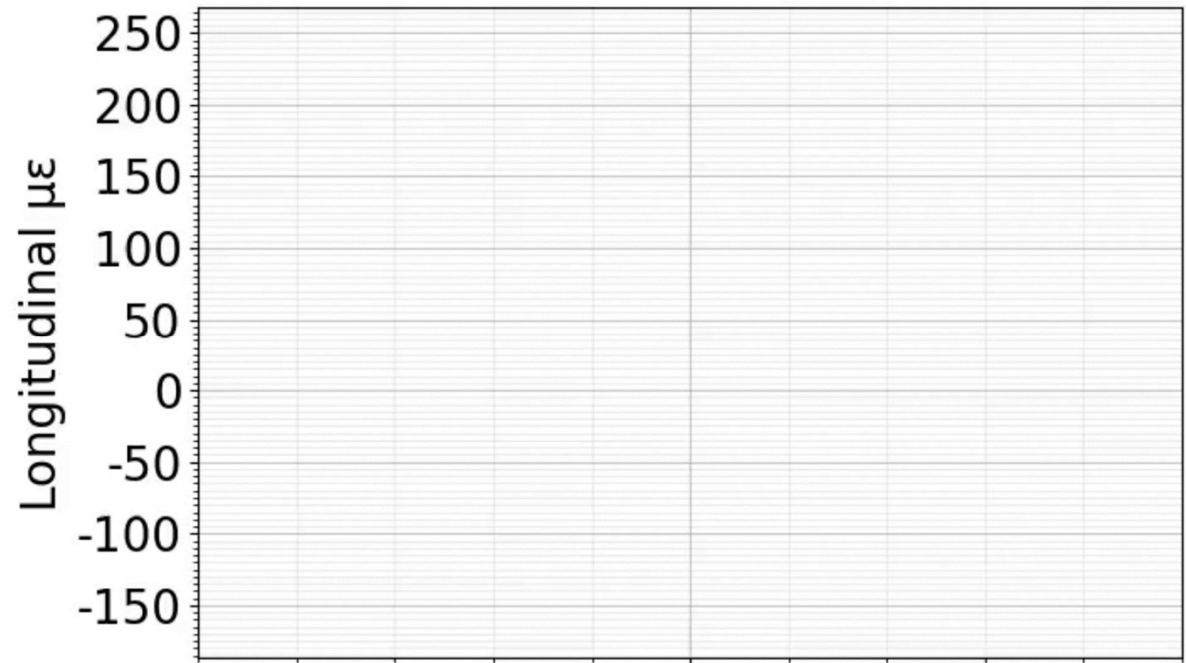
S#1 (Extracted)	-563.394
S#2 (Extracted)	-779.820
S#1 (Extracted)	-215.845
S#2 (Extracted)	-3.481



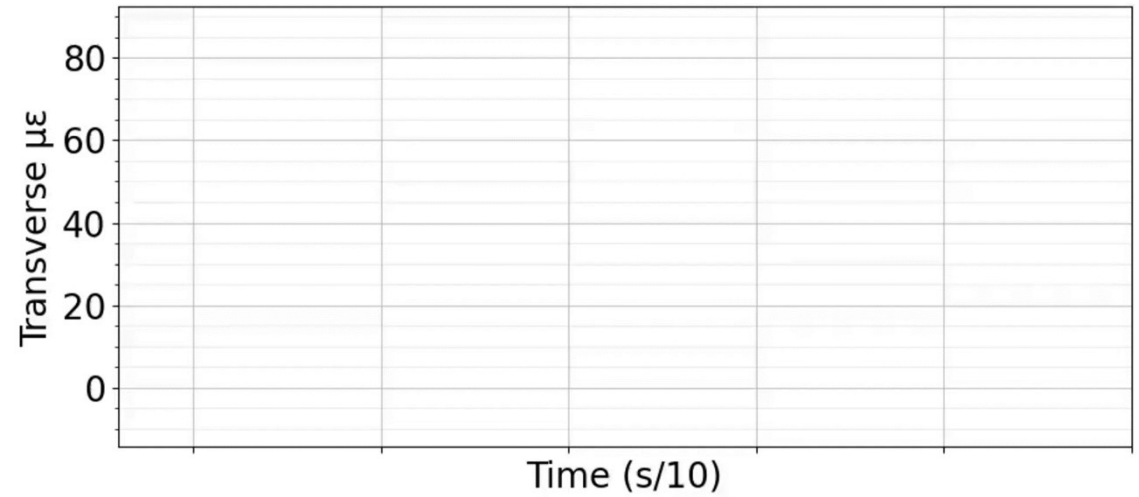
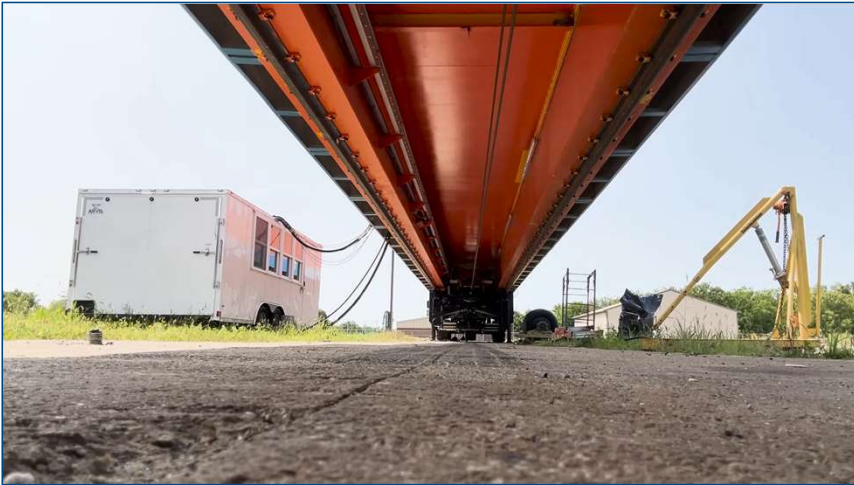
Vertical Pressure



Longitudinal Strain

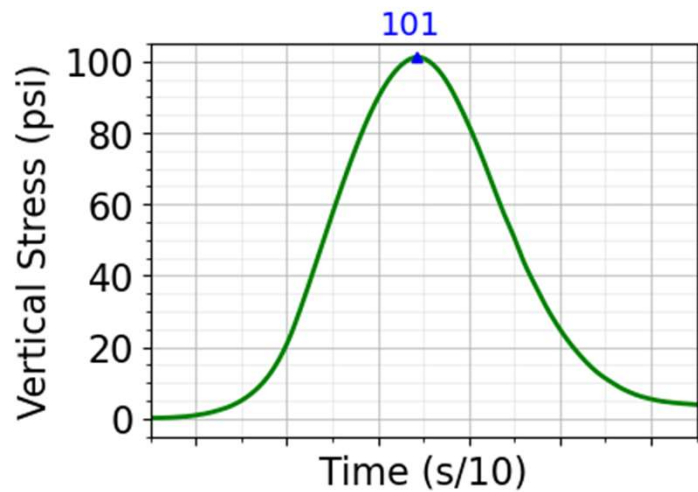


Transverse Strain

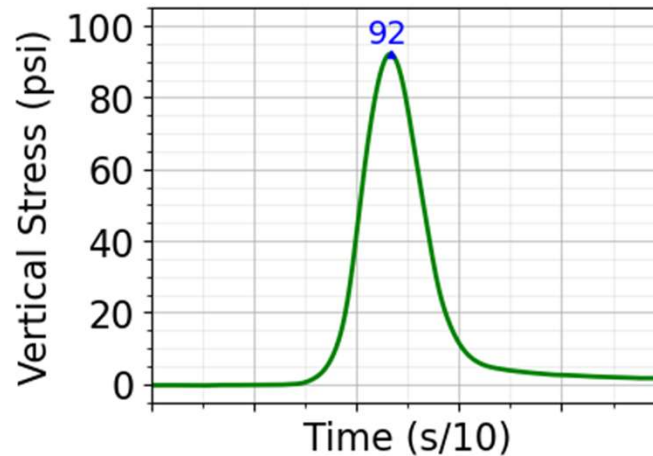


Effect of Speed on Vertical Pressure

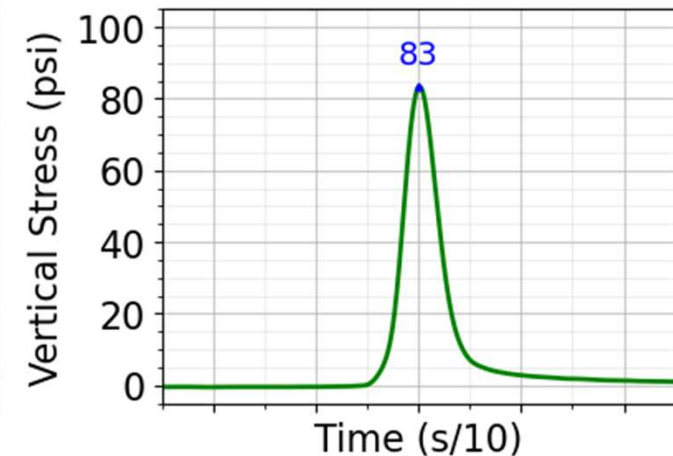
1mph



3mph

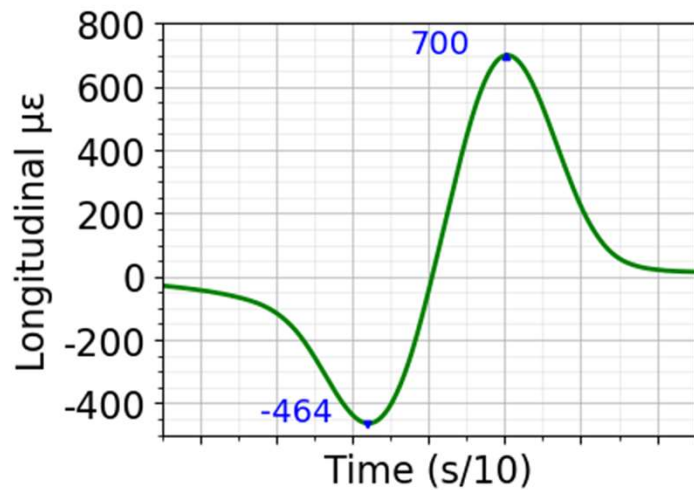


5mph

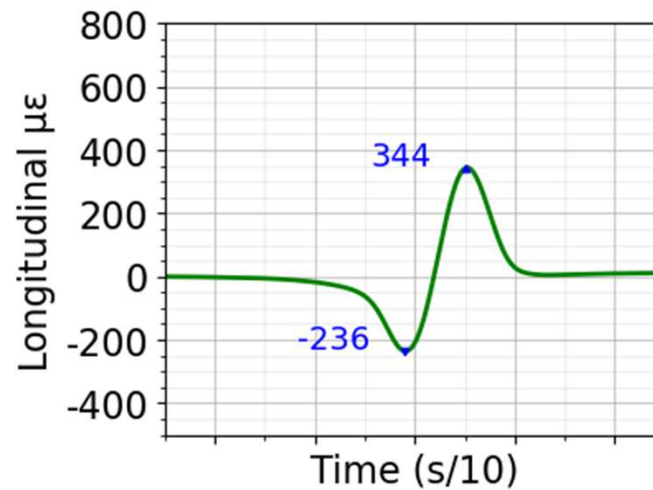


Effect of Speed on Longitudinal Strain

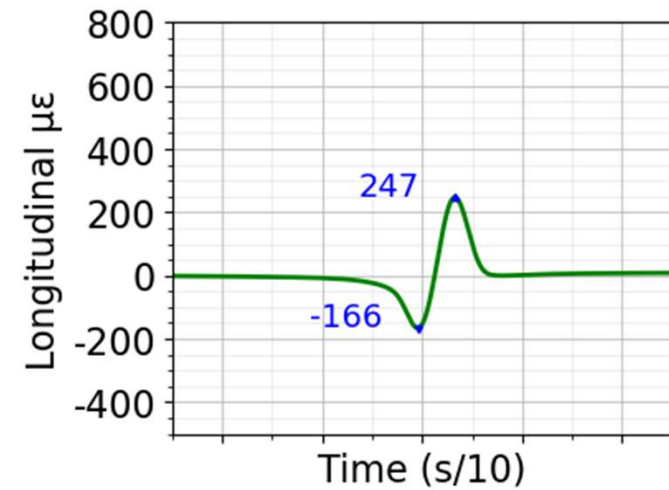
1mph



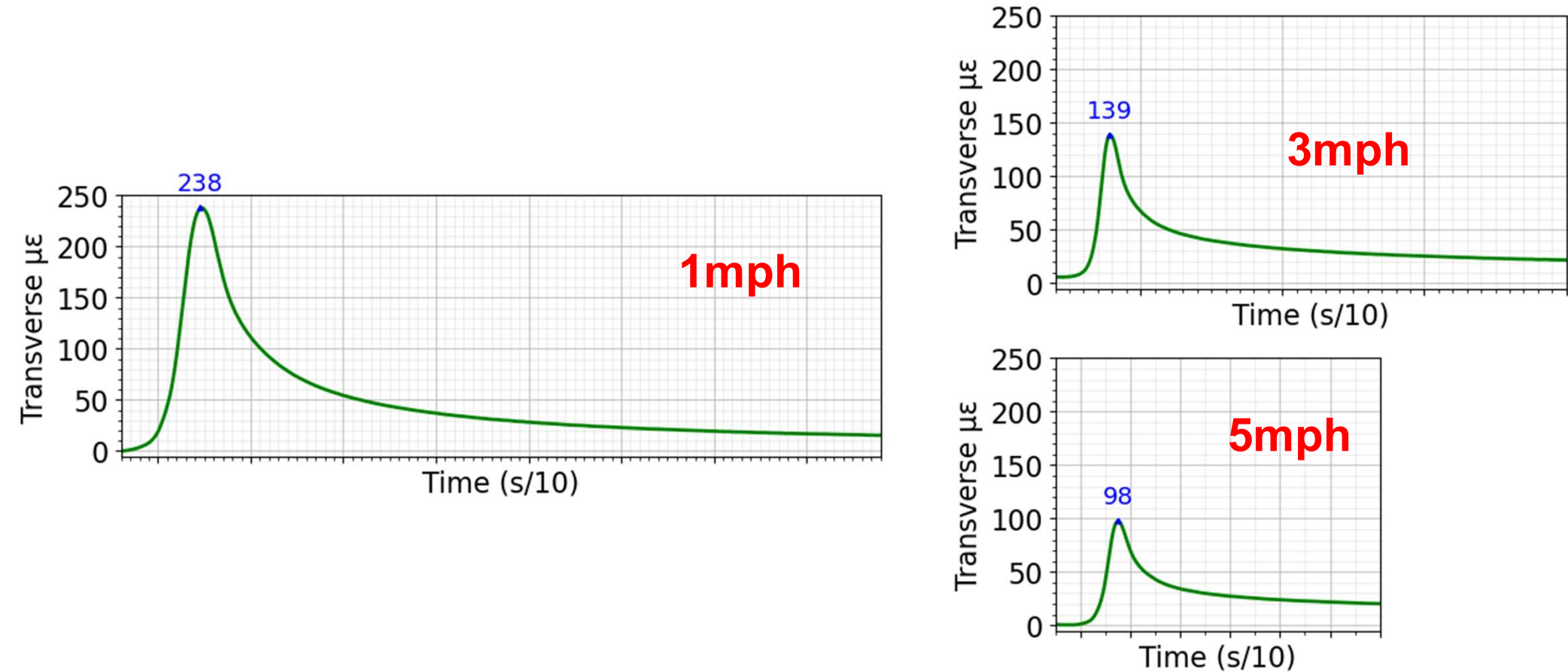
3mph



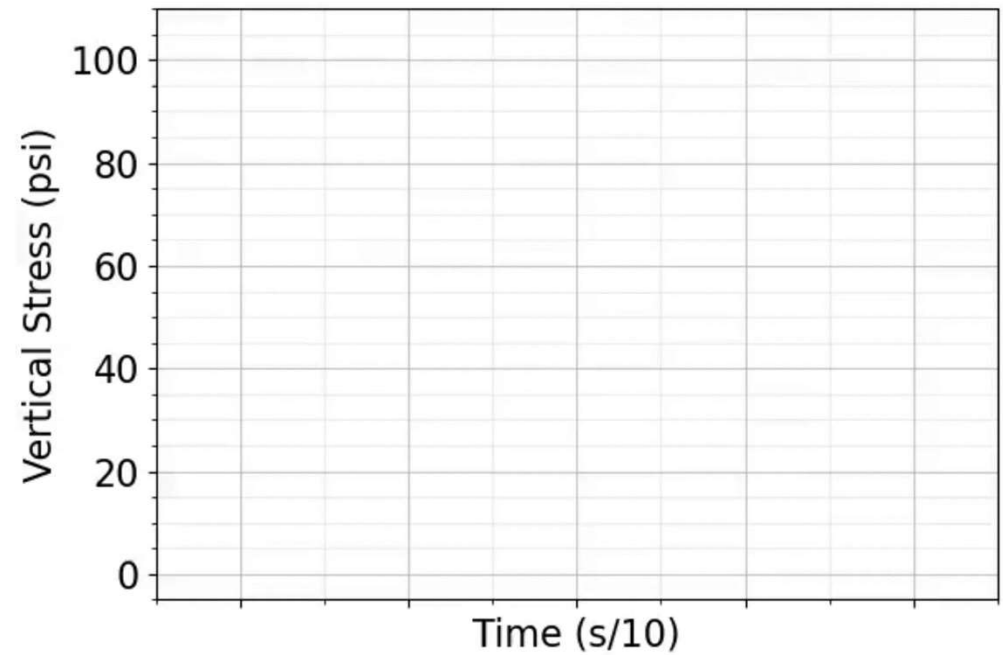
5mph



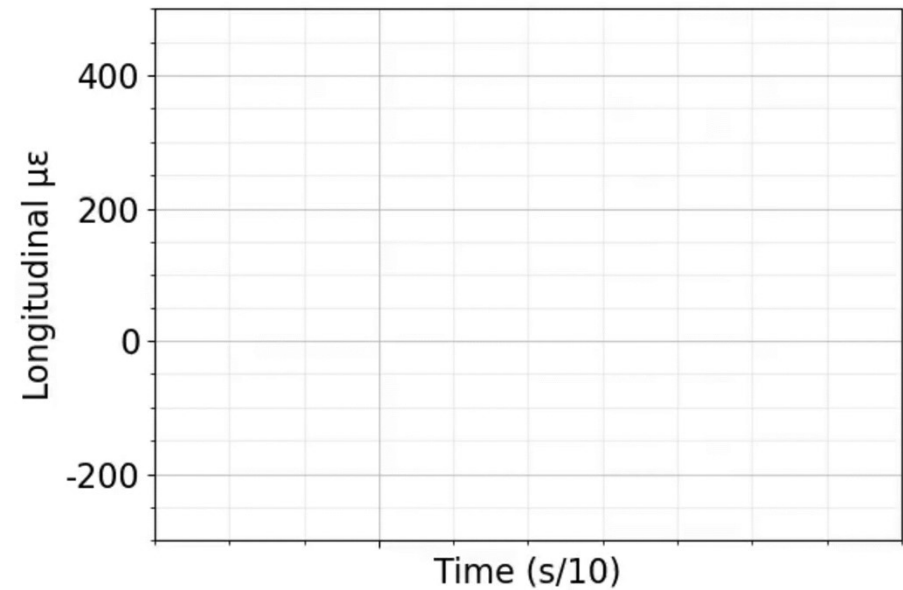
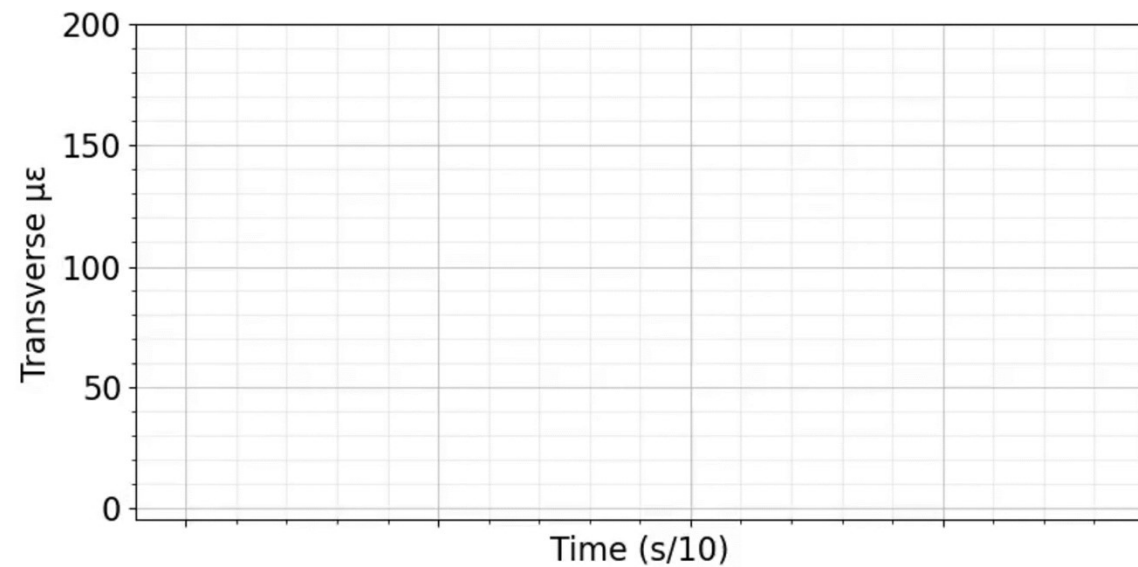
Effect of Speed on Transverse Strain



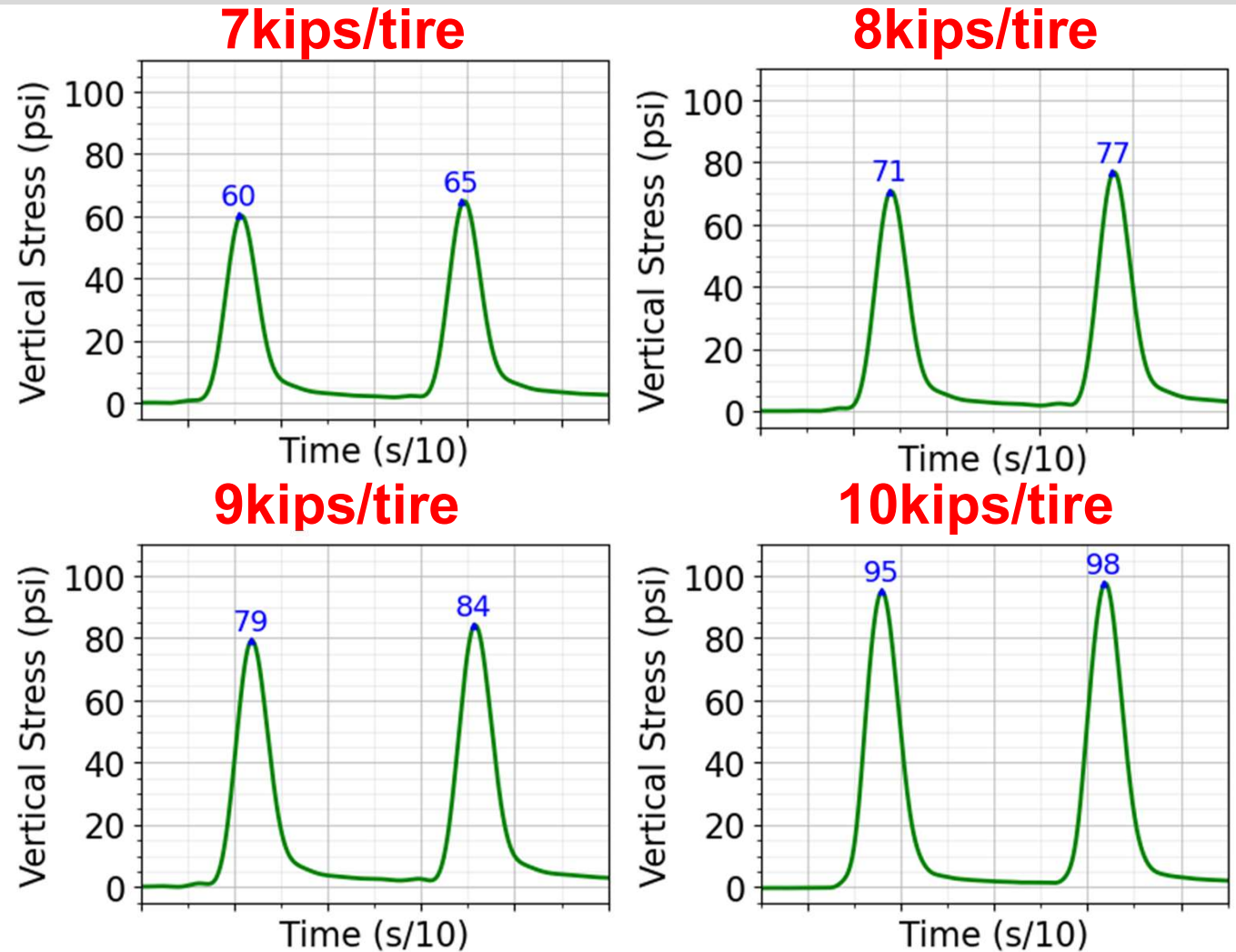
Effect of Tandem Axle on Vertical Pressure



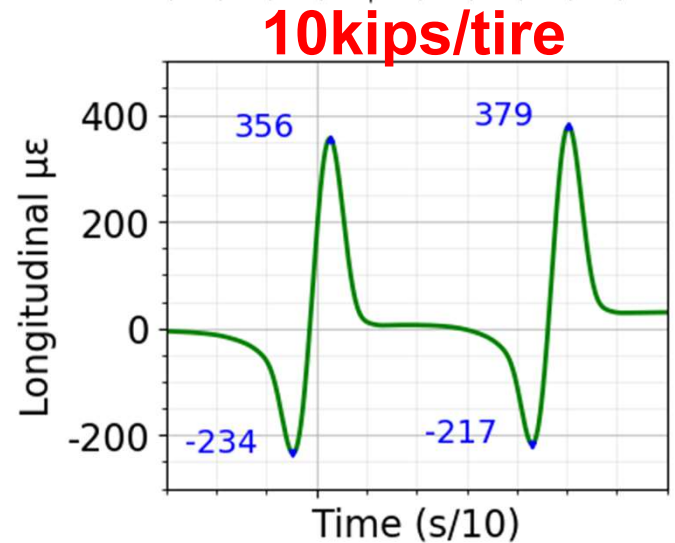
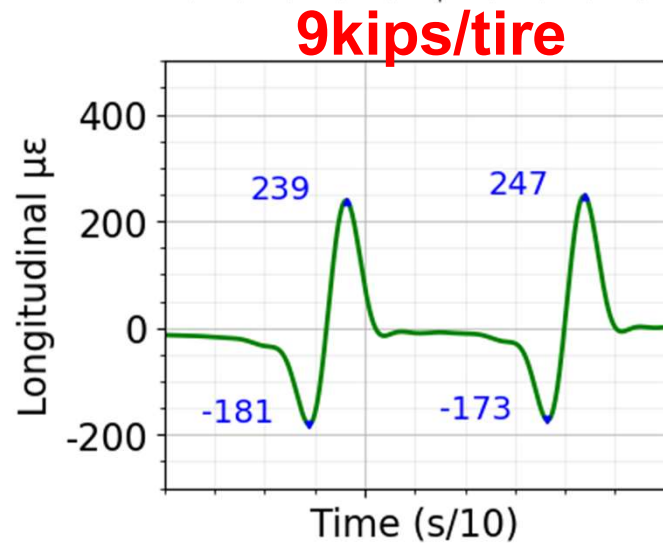
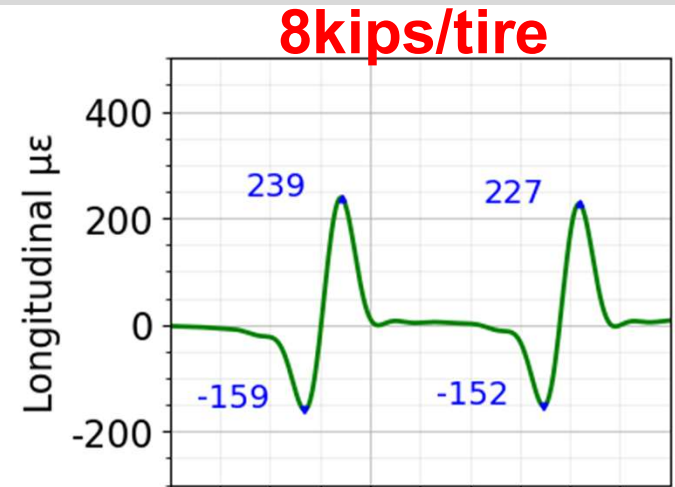
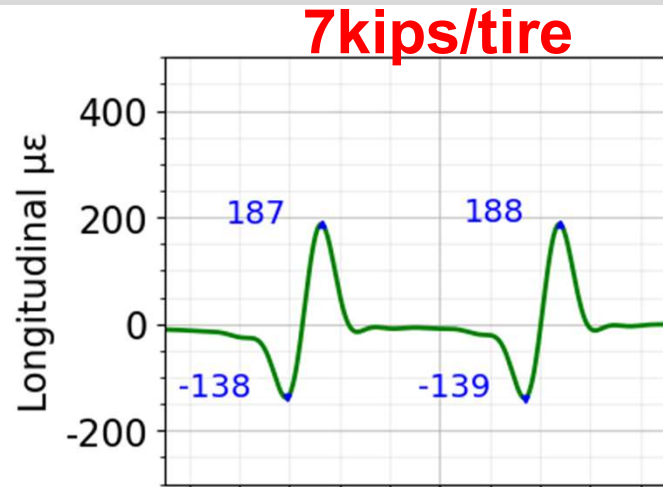
Strains due to Tandem Axle Loading



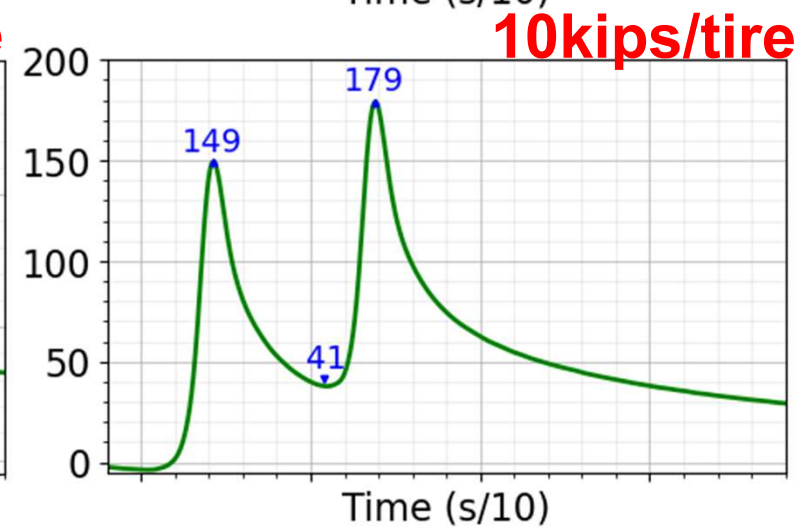
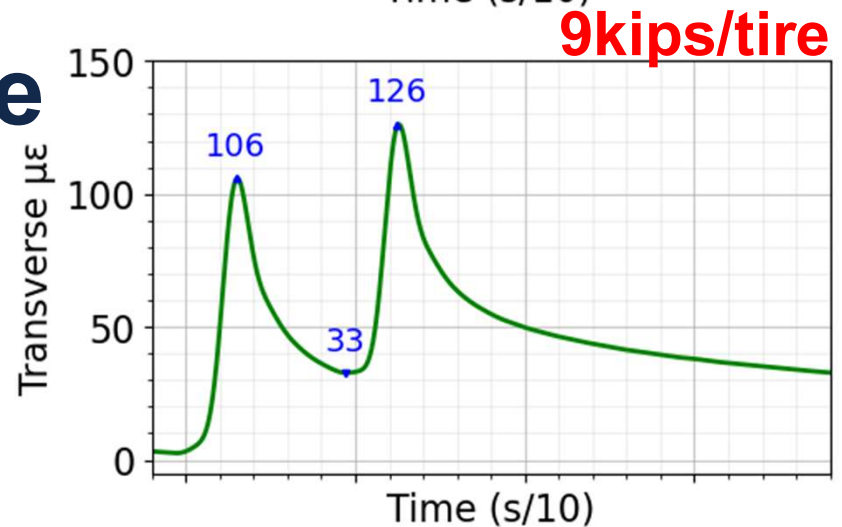
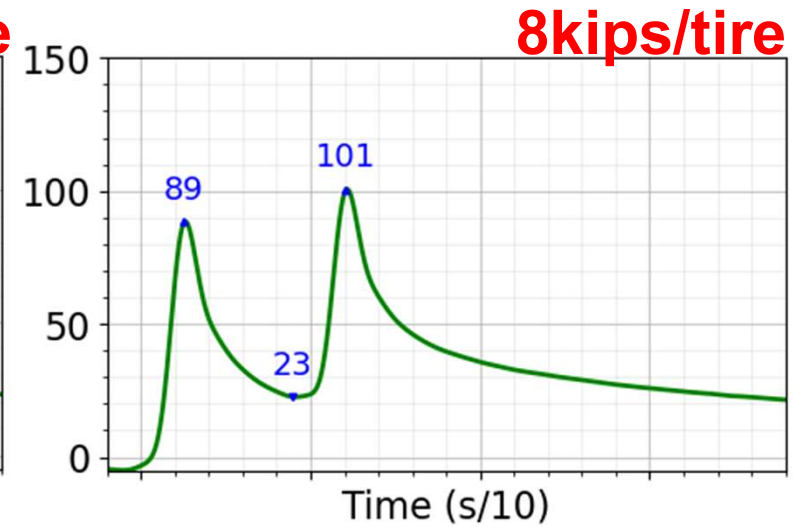
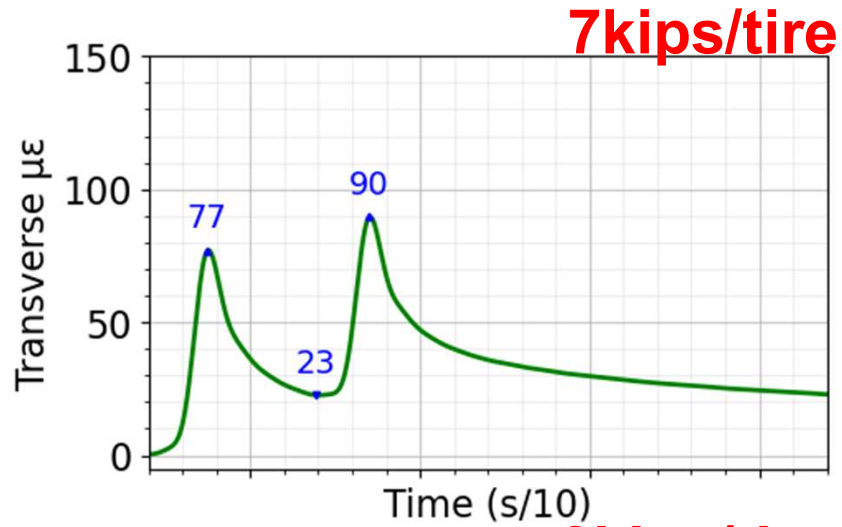
Effect of Tandem Axle on Vertical Pressure



Effect of Tandem Axle on Longitudinal Strain



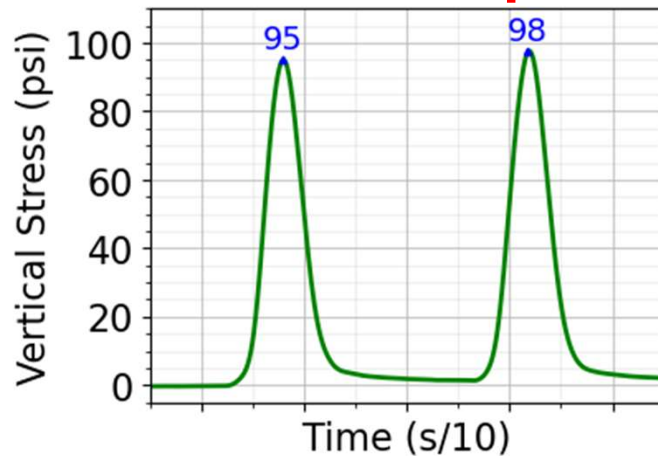
Effect of Tandem Axle on Transverse Strain



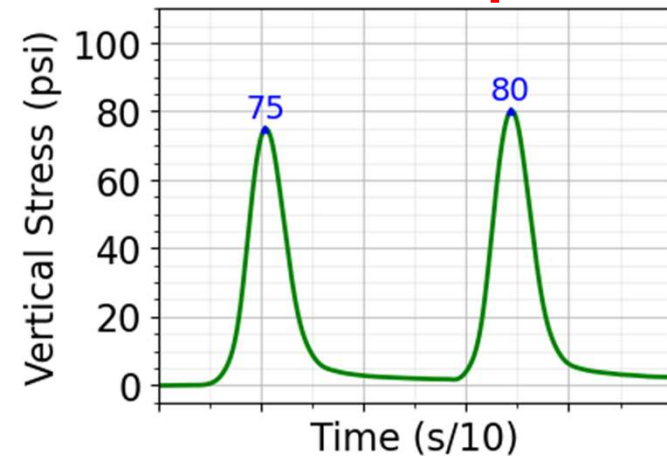
Tire Inflation Pressure Effect on Near Surface



120 + 120psi

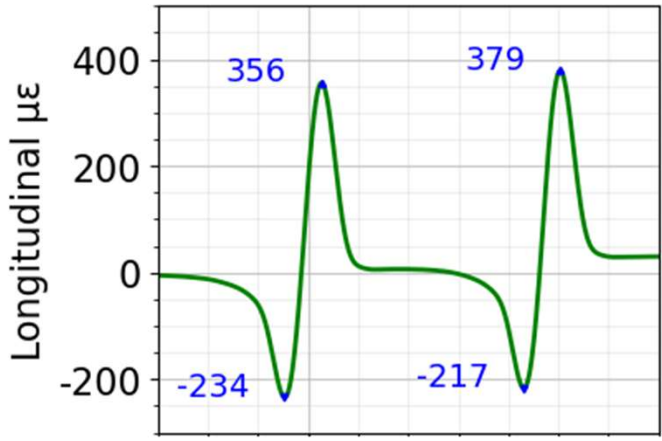
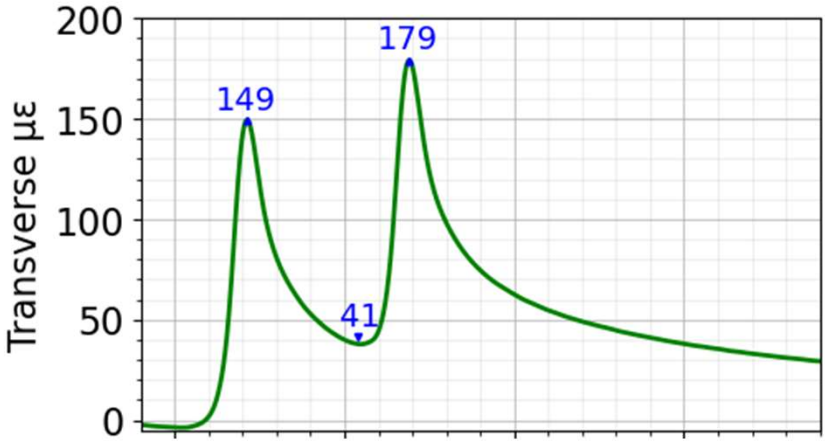


80 + 80psi

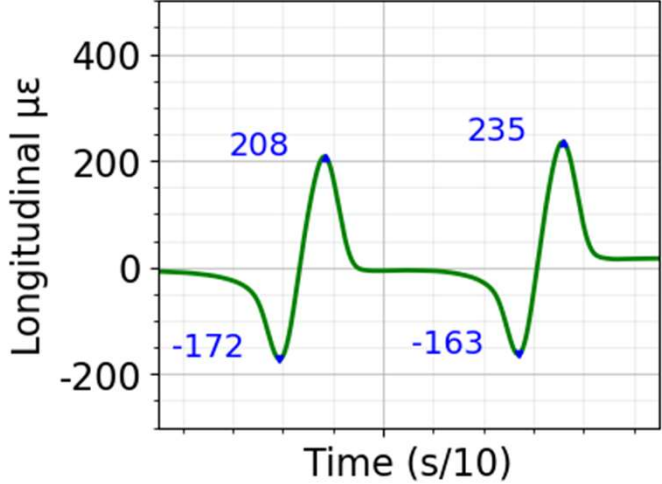
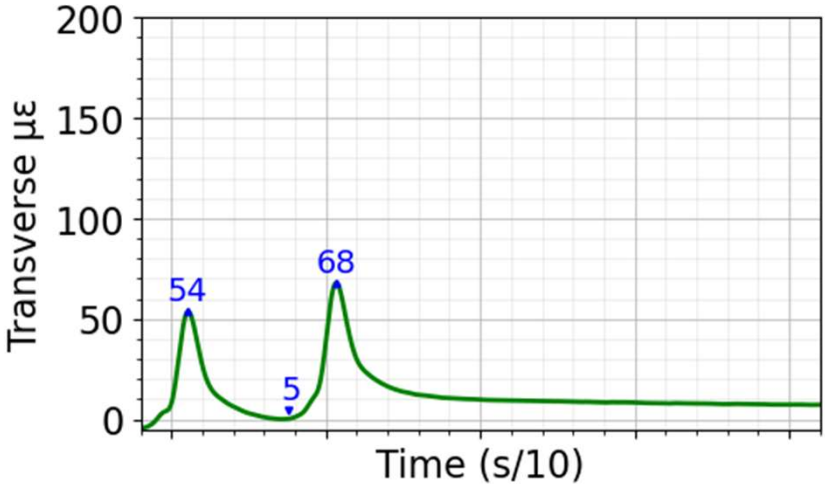


Effect of Tire Inflation Pressure on Strains

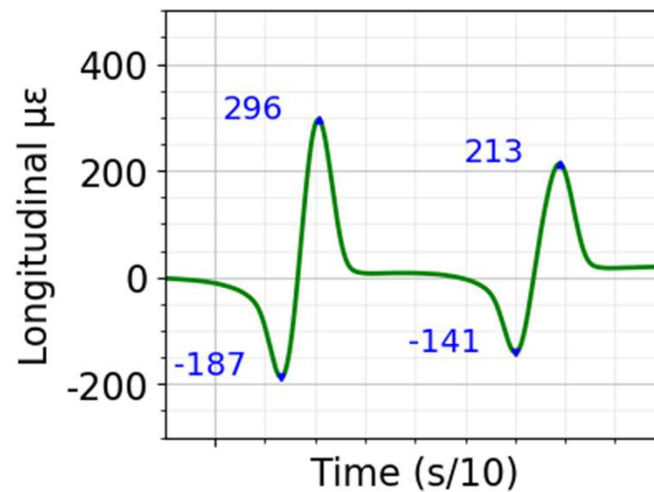
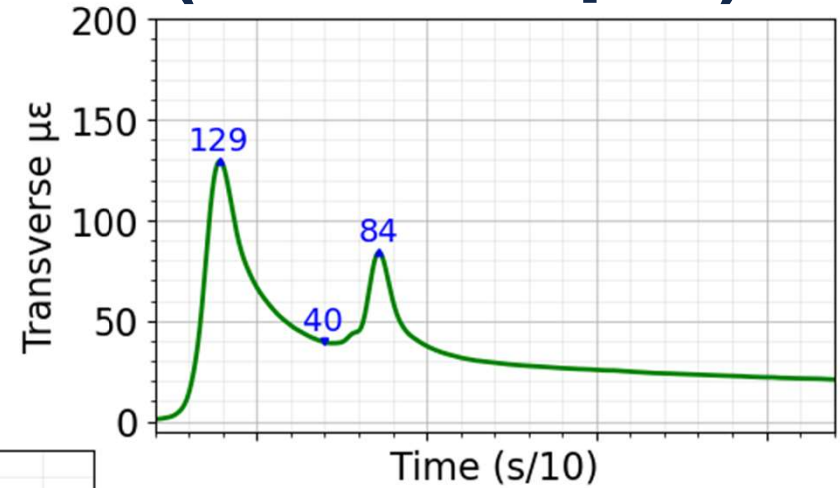
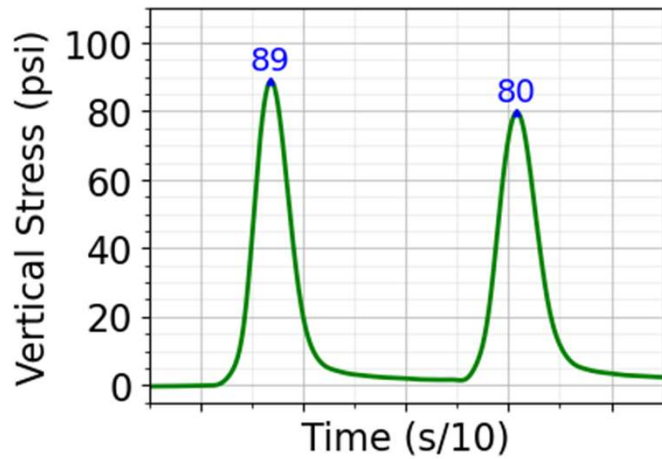
120psi
120psi



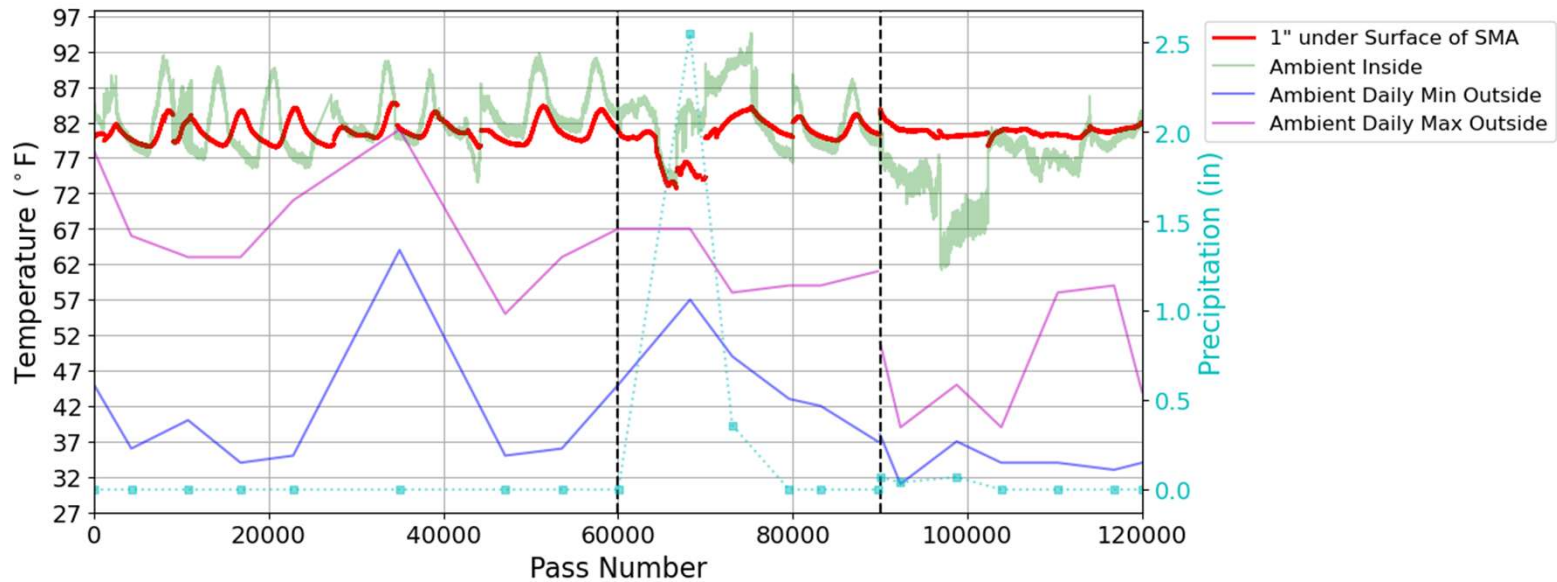
80psi
80psi



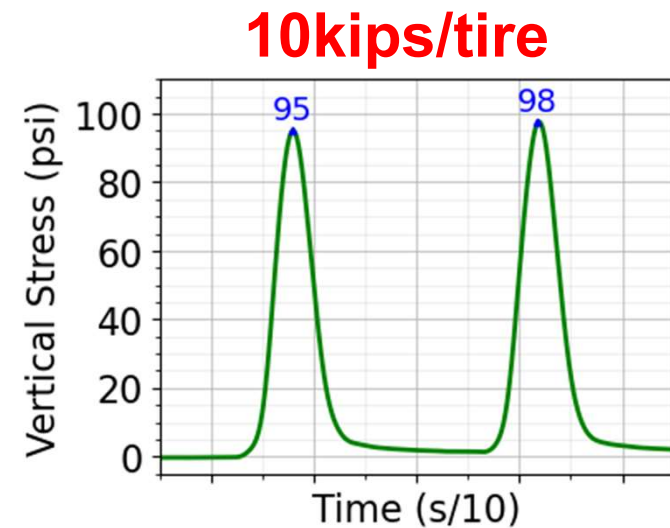
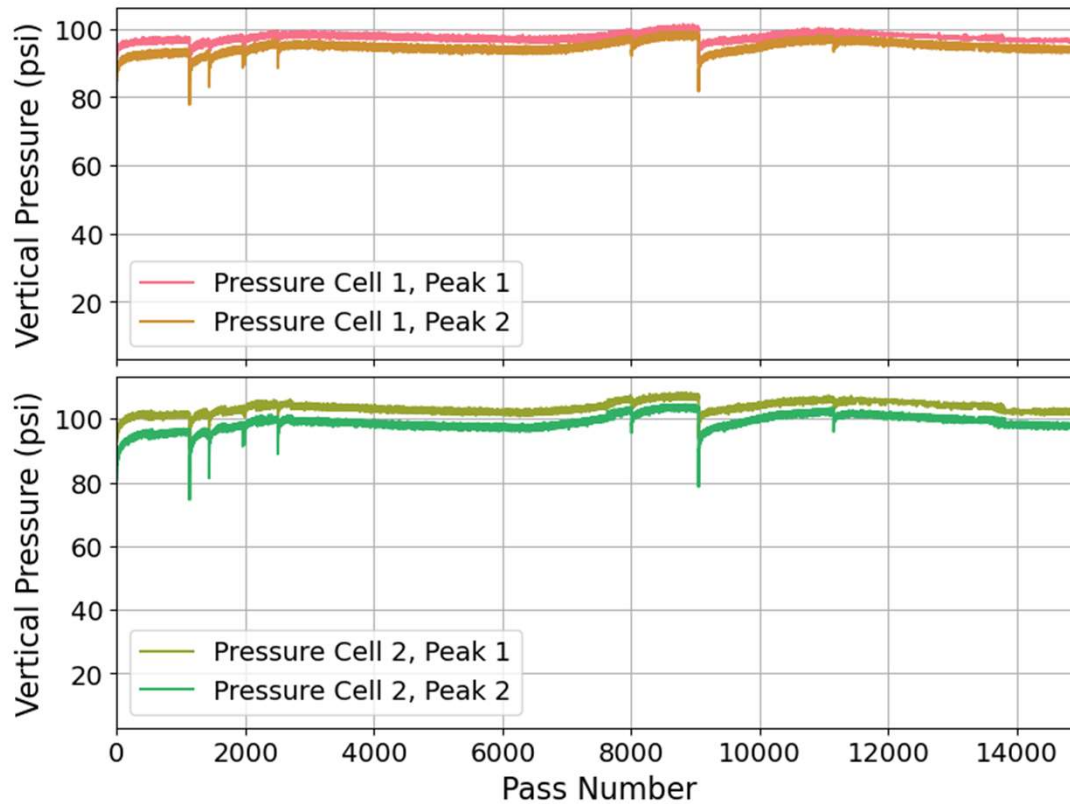
Deflated One Tandem Tire (120 + 80psi)



Temperature Control (Rutting Test)

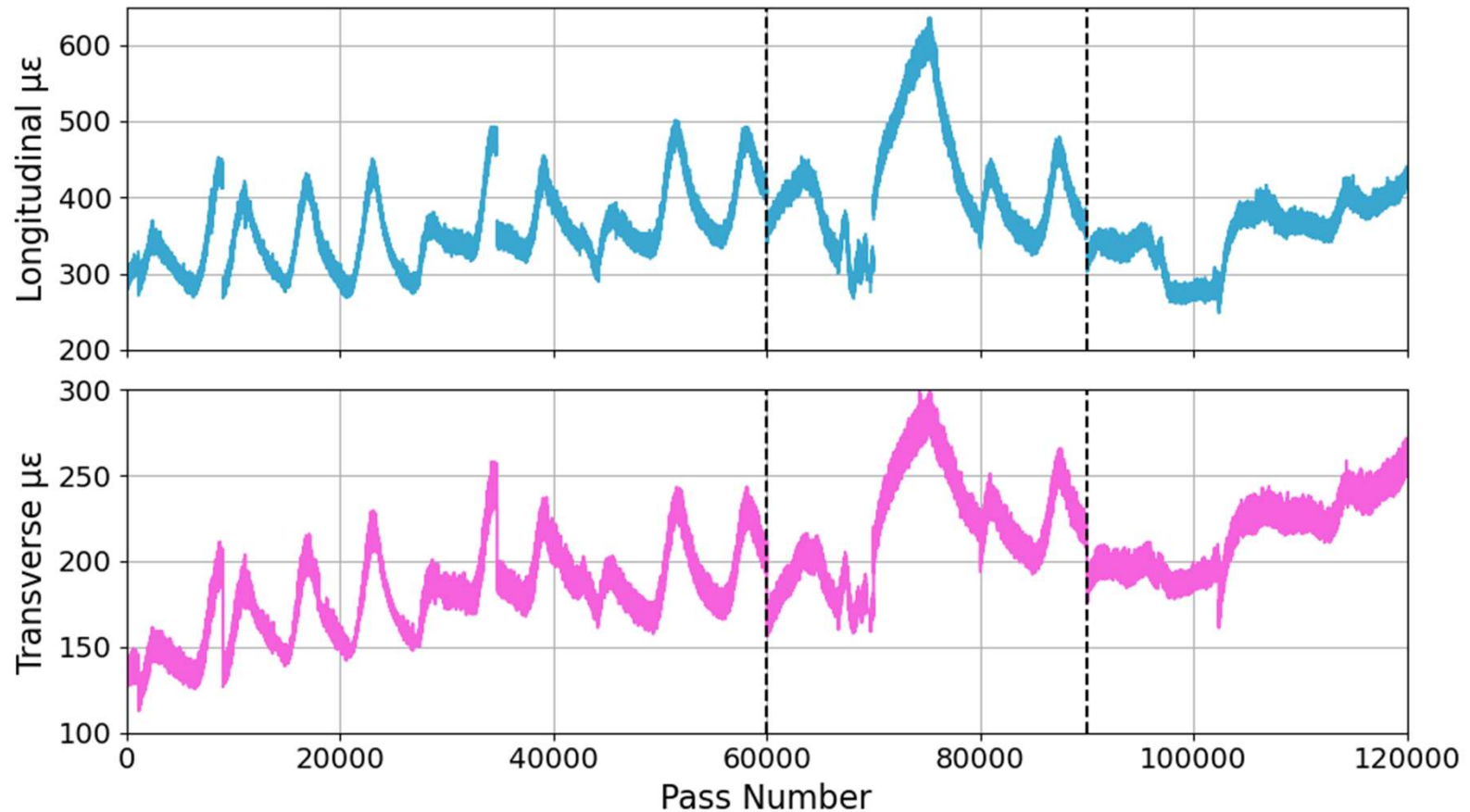


Vertical Pressure (Rutting Test)

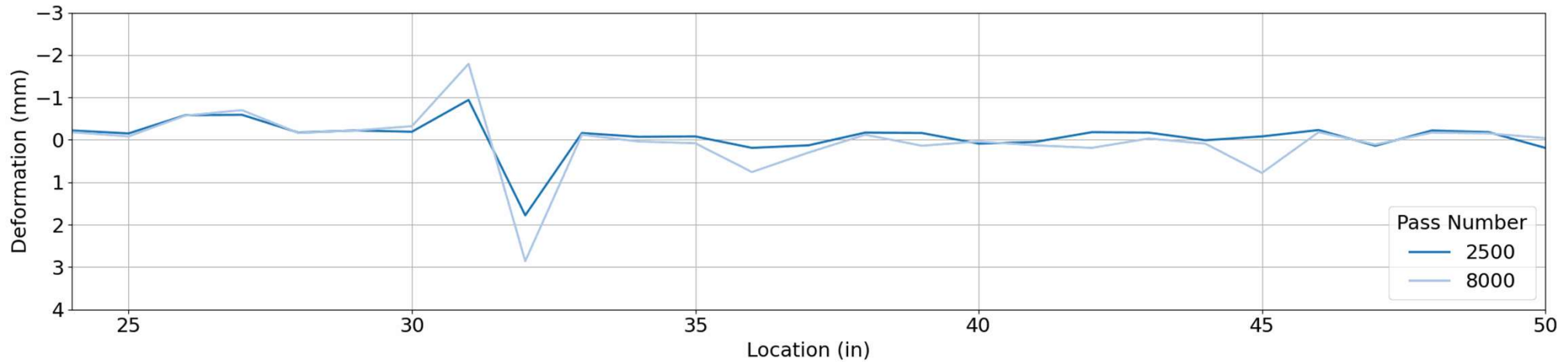


Effect of Temperature + Damage (Rutting Test)

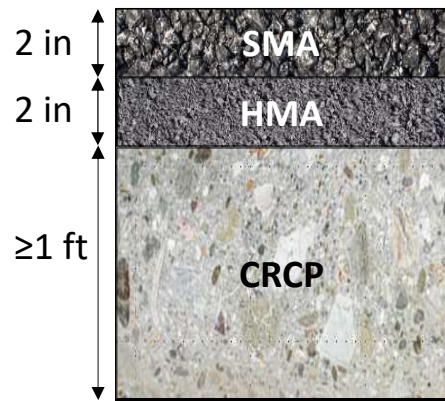
Peak Strain - Second Axle



Damage Progression



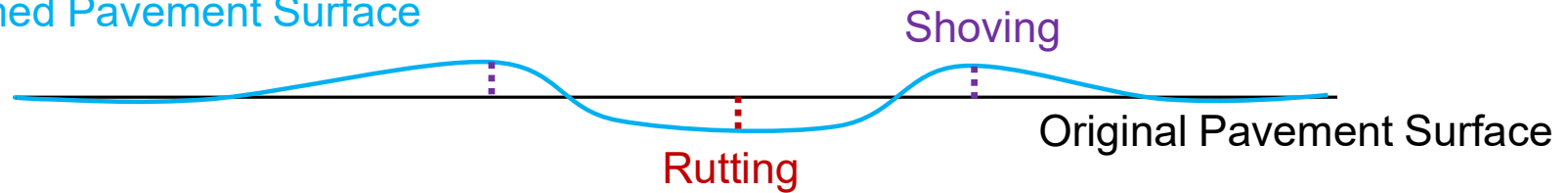
Results for First Section: D4-50-12.5-0



← Aggregate: Dolomite of the highest L.A. abrasion loss.

■ 400,000 Equivalent Single Axle Loads (ESALs)

Deformed Pavement Surface



Acknowledgements

- **IDOT**
- **R27-216 technical research panel members**
- **ICT students, engineers, faculty, and staff**
- **Participant aggregate and asphalt producers**



THANK YOU
Questions?

Illinois Center for Transportation

